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POWER SUPPLY
INSTRUCTION MANUAL

MODEL	RSF 15

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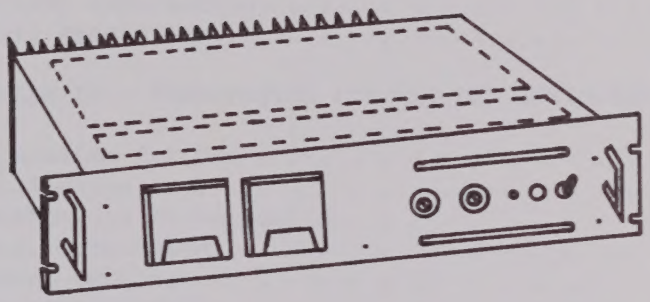
F SERIES POWER SUPPLY



instruction manual

NJE

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TABLE OF CONTENTS

Paragraph		Page
	SECTION I - INTRODUCTION	
1-1	Scope	1-1
1-2	Function	1-1
1-3	Performance	1-1
1-4	Comparative Specifications	1-1
1-5	Features	1-1
1-6	Environmental Requirements	1-3
1-7	Items Furnished	1-3
1-8	Items Required	1-3
1-9	Warranty Information	1-5
1-10	Safety Precautions	1-5
	SECTION II - PREPARATION FOR USE AND INSTALLATION	
2-1	Preparation for Use	2-1
2-2	Installation	2-1
2-2-1	Mechanical Installation	2-1
2-2-2	D.C. Connections	2-1
2-2-3	Local Sensing	2-1
2-2-4	Remote Sensing	2-2
2-2-5	Remote Resistance Programming	2-2
2-2-7	Remote Voltage Programming	2-2
2-2-9	A.C. Connections	2-2
	SECTION III - THEORY OF OPERATION	
3-1	General Theory of Operation	3-1
3-2	Detailed Circuit Description	3-1
	SECTION IV - OPERATING INSTRUCTIONS	
4-1	General Operating Instructions	4-1
4-2	Control Functions	4-1
4-3	Normal Operation	4-2
4-4	Over Voltage Protection	4-2
4-5	Shutdown	4-2
	SECTION V - MAINTENANCE INSTRUCTIONS	
5-1	Routine Maintenance	5-1
5-2	Troubleshooting Instructions	5-1
5-3	Voltage Adjust Setting Procedure	5-1
5-4	Current Limit Setting Adjustment	5-1
5-6	Over Voltage Protection Adjustment	5-4
5-8	Performance Verification	5-5
5-17	Disassembly, Repair, Replacement, Reassembly	5-7
5-18	Packing for Reshipment	5-7
5-19	Storage Instructions	5-8

LIST OF ILLUSTRATIONS

Figure Number		Page
1.	Cable Drop as a Function of Cable Length	a
2.	Local Sensing Connection	a
3.	Remote Sensing Connection	a
4.	Remote Resistance Programming with Local Sensing	b
5.	Remote Resistance Programming with Remote Sensing	b
6.	Remote Voltage Programming with Local Sensing	b
7.	Remote Voltage Programming with Remote Sensing	b
8.	General Circuit Block Diagram	c
9.	Test Connection for Performance Verification	c
10.	Outline Drawing	d
11.	Interface Drawing	e
12.	Parts Placement Diagram	f
13.	Schematic Diagram	g

LIST OF TABLES

Table Number		Page
1.	Voltage and Current Ratings, F Series Power Supply	1-2
2.	Table of Specifications, F Series Power Supply	1-4
3.	Troubleshooting Chart	5-2

APPENDIX

Parts List (Spare) . . . . . Rear of Manual

1-1. SCOPE.

This manual is intended for use as a complete guidebook and reference document pertaining to the installation, testing, maintenance, and repair of the NJE F series rack mount power supply. Complete parts placement drawings, schematic diagram, test voltages, installation diagrams, and trouble shooting chart are included for the installation and maintenance of the F series power supply.

1-2. FUNCTION.

The RS, RX, and RJ series F power supply is a self-contained solid state unit operating from the AC line and supplying well-regulated DC voltage and current to electronic equipment. This power supply series is intended for medium to high-current applications and is mountable in a standard 19-inch RETMA relay rack cabinet.

1-3. PERFORMANCE.

The NJE RS, RX, and RJ line of power supplies are all silicon solid state circuits and include the utilization of integrated circuits. Additionally, all supplies are series regulated and are manufactured with high quality industrial grade components. The quality of the power supply is consistent with that required for the most sophisticated computer grade electronic systems in use today. The circuits used are extremely reliable and feature a high degree of simplification. The circuit simplification results in standardization of material and also gives greater reliability due to the reduction of components used in the basic circuits. The overall design philosophy utilized in this product line is based on standardization, simplicity, reliability, and high quality. For the output current ratings and voltages of standard models available in the F series, refer to Table 1.

1-4. COMPARATIVE SPECIFICATIONS.

Table 2 lists in chart form the specifications of the RS, RS, and RJ models of the F series power supply.

1-5. FEATURES.

1-5-1. OVER VOLTAGE PROTECTION (OVP) (Optional). SCR crowbar to limit maximum output voltage. Normally factory set at 1.5V or 20% (whichever is greater) above the nominal output voltage. OVP may be readjusted by customer via accessible adjustment. (See Maintenance Instructions)

1-5-2. CURRENT LIMITING. Current limiting may be set to limit maximum current from 75% to 120% of rated current. This current limiting adjustment is located internally and can be readjusted by customer. (See Maintenance Instructions)

TABLE I

VOLTAGE AND CURRENT RATINGS, F SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RFJ 2	2 ± 0.1V	85.0	72.0	59.5	46.7
RSF 5	5 ± 0.5V	60.0	51.0	42.0	33.0
RJF 5	5 ± 0.25V	85.0	72.0	59.5	46.7
RSF 10	10 ± 1.0V	39.0	33.0	27.3	21.4
RSF 12	12 ± 1.0V	34.0	28.9	23.8	18.7
RJF 12	12 ± 0.6V	50.0	42.5	35.0	27.5
RSF 15	15 ± 1.0V	30.0	25.5	21.0	16.5
RJF 15	15 ± 0.75V	45.0	38.2	31.5	24.7
RSF 18	18 ± 1.0V	28.0	23.8	19.6	15.4
RSF 20	20 ± 1.0V	25.0	21.2	17.5	13.7
RSF 24	24 ± 1.0V	24.0	20.4	16.8	13.2
RJF 24	24 ± 1.0V	30.0	25.5	21.0	16.5
RSF 28	28 ± 1.0V	20.0	17.0	14.0	11.0
RJF 28	28 ± 1.0V	28.0	23.8	19.6	15.4
RSF 36	36 ± 1.5V	15.0	12.7	10.5	8.3
RSF 48	48 ± 2.0V	12.0	10.2	8.4	6.6
RJF 100	100 ± 5.0V	3.80	3.50	3.19	2.89
RJF 120	120 ± 6.0V	2.30	2.11	1.93	1.75

NOTES: 1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

1-5-3. REMOTE PROGRAMMING. 1 volt per volt or 500 ohms per volt (output terminal strip). See Section II for detailed connection information to operate supply in remote programming mode.

1-5-4. REMOTE SENSING. Sensing terminals separate from the load terminals provide regulation of the voltage at the load rather than regulation of the voltage at the power supply output terminals. This eliminates loss of load regulation due to the voltage drop in the wires connecting the supply to the load.

1-5-5. FAULT PROTECTION. All power supplies are protected with primary fuses and/or circuit breakers.

1-5-6. MISCELLANEOUS FEATURES. The following features are optionally available on the F series power supplies: terminal board cover for input/output connection protection; line cord (3-wire U-ground); meters for monitoring output voltage and current; 187-242 or 205-265 V RMS input; and chassis drawer slides.

1-6. ENVIRONMENTAL REQUIREMENTS.

The F series power supply is designed to be operated in a free-air (convection) mode. Special cooling and/or forced air (blower or fan) is not required for normal room temperature installations. Room temperature is considered to be nominal 25° centigrade. However, should the power supply be operated in an ambient environment greater than 40° centigrade, the current output of the supplies must be derated at the rate of (1.5%/°C) up to a maximum ambient operating temperature of 70° centigrade. The F series power supplies are commercial-grade equipments intended for fixed ground installation and should not be subjected to extreme adverse conditions of shock, vibration, or salt spray, etc.

1-7. ITEMS FURNISHED.

The F series power supply is furnished complete and pretested and is ready to install in a standard RETMA 19-inch relay rack cabinet. Consult the Preparation for Use and Installation section of this manual for installation instructions.

1-8. ITEMS REQUIRED.

Required to put the F series power supply in operation is a suitable 3 wire, U-ground receptacle supplying 115VAC, 60 hertz nominal (except in the case of supplies operated from 180 to 260VAC line). Wattage requirements are given in Table 1. A line cord will be necessary between power supply and receptacle, unless the line cord option is equipped. Interconnecting wiring from the power supply and equipment being powered is required as determined by the end useage of the power supply. Stranded wire insulated with PVC or teflon covering is recommended for interconnecting wiring and it is recommended that shielded cable be used for sense leads between supply and load if remote sensing is desired. (See Section II for explanation of remote sensing.) Refer to Figure 1 for determination of proper wire size required for the load connections. Additionally, mounting screws are required to fasten the power supply system to the mounting rack. These screws of proper thread and length are usually supplied with the mounting rack.

TABLE 2

TABLE OF SPECIFICATIONS, F SERIES POWER SUPPLY.

SPECIFICATION	RS	RX	RJ
INPUT REQUIREMENTS	105-132V RMS @ 47-440 HZ.	*105-125V RMS @ 57-63 HZ.	105-125V RMS @ 47-440 HZ.
REGULATION			
MIN-MAX LINE	0.01% + 1 mV	0.1% + 1 mV	0.1% + 1 mV
NO LOAD TO FULL LOAD	0.01% + 1 mV	0.1% + 1 mV	0.1% + 1 mV
RIPPLE AND NOISE	1.0 mV RMS; 3 mV P-P		
TEMPERATURE RANGE			
OPERATING	-20°C to +71°C	0°C to +71°C	0°C to +71°C
STORAGE	-55°C to +85°C	-55°C to +85°C	-55°C to +85°C
STABILITY (LONG TERM DRIFT)	0.1% (24 HR PERIOD, AFTER 1/2 HR WARM-UP)		
TRANSIENT RECOVERY TIME	25 MICROSECONDS TO 0.1%		
OVERSHOOT (OUTPUT)	NONE ON TURNON OR TURNOFF		
OVERCURRENT PROTECTION	CURRENT FOLDBACK ADJUSTABLE 75-125% OF OUTPUT RATING		
REMOTE PROGRAMMING			
RESISTANCE	500 OHMS PER VOLT (OR)		
VOLTAGE	1 VOLT PER VOLT		
REMOTE SENSING	PROVIDED		
INPUT PROTECTION	FUSE AND HOLDER ON FRONT PANEL		
CONNECTIONS	CINCH 141 TERMINAL BLOCK ON REAR FOR ALL CONNECTIONS. 3/8-16 OUTPUT STUD AT REAR FOR POWER CONNECTIONS		
CONTROLS			
VOLTAGE ADJUST	LOCATED ON FRONT PANEL (LOCKABLE)		
OVP ADJUST	LOCATED ON FRONT PANEL (LOCKABLE)		
FINISH	GOLD IRRIDITE CHASSIS, FRONT PANEL LIGHT BLUE PAINT, FEDERAL STD 595-COLOR 25109		
MOUNTING	STANDARD RETMA RELAY RACK MOUNTING (19")		
COOLING	NORMAL CONVECTION COOLING, NO EXTERNAL HEAT SINKS REQUIRED		
SIZE	3-15/32 X 19 X 16-7/16		
WEIGHT	48 POUNDS		
INPUT POWER REQUIREMENTS	900 - 1200 VOLT-AMPS		

*Units may be operated at 47 - 53 HZ by derating to the next highest temperature range. See Table 1.

1-9. WARRANTY INFORMATION.

All NJE F series power supplies are warranted for five (5) years from manufacture date. The NJE warranty statement is reproduced below:

> NJE guarantees all power supplies manufactured by it to be free from defects in material or workmanship. Our guarantee under this is limited to servicing or adjusting any instrument returned to the factory or to an NJE full service center (prepaid) for that purpose, and to provide all the needed labor and material at no charge. This guarantee is good for five (5) years from the date of manufacture. If this power supply is sold to a manufacturer who is using it in a system, as an OEM buyer, which he is reselling, the guarantee above is transferable to the end user. The provisions of this guarantee shall not apply to any power supply which has been subject to misuse or which has been repaired or altered by the purchaser or end user in any way so as, in the judgement of NJE, to adversely affect its performance.

Note power supply(s) should not be returned to the factory for inwarranty repair unless the unit remains inoperable after referring to the troubleshooting section of this manual, and carrying out the instructions therein. For repair service or advice concerning an application problem, please contact the factory.

1-10. SAFETY PRECAUTIONS.

HAZARDOUS VOLTAGES. The F series power supplies are powered by 115 volt AC line voltage which is a hazardous voltage to maintenance personnel. It is recommended the power supply be installed in its respective rack mounts and the DC output connections be installed prior to plugging in the AC line cords. The power supply may then be turned on by the circuit breaker on the front panel. No hazardous voltages are present to the operator of the equipment during normal useage.

WARNING

Observe proper safety procedures for 115 volt AC levels when troubleshooting or servicing the F series power supply.

Service and troubleshooting should only be performed by a qualified technician. Aside from the 115 volt AC line voltage, no other hazardous voltages exist within the power supply.

SECTION II

PREPARATION FOR USE AND INSTALLATION

2-1. PREPARATION FOR USE.

Unpack the power supply carefully and temporarily save all packing material in case physical damage is discovered. Read and save all instruction material which may be included with the unit. Inspect carefully for physical damage which may have occurred in shipping. Particularly look for broken meters (cracked faces or needles not zeroed), broken controls or fuse holders, and dents, loose hardware and missing parts. Refer to Figure 10 for an outline drawing of the F series power supply showing assemblies and controls.

2-2. INSTALLATION.

Do not attempt to operate the power supply if obvious mechanical damage has occurred. If the power supply has not sustained any shipping damage it may be installed. Check that the fuse is in place (see parts list for correct fuse values) and that all power switches are in the off position.

NOTE

Make all connections to the system before applying power.

2-2-1. MECHANICAL INSTALLATION. Mount the power supply in a 19-inch wide relay rack cabinet, usually with the equipment to be powered. Standard procedure is to mount the power supply(s) at the bottom of the rack cabinet, but this is not mandatory provided the ventilation requirements of paragraph 1-6 are met. Support the power supply while fastening it in place using four (4) screws which must be provided. The power supply mounts by its front panel which has four (4) slots provided for the mounting screws. Mounting screws should be washered and snugged down tightly (minimum of 20 in.-lbs. torque).

2-2-2. DC CONNECTIONS. A pair of 3/8-16 threaded output studs is provided at the rear of the F series power supply. Lugs should be attached to the power connection wires prior to fastening to the output studs. Determination of correct wire size for power connections may be made by consulting Figure 1.

NOTE

The positive and negative sensing leads must be connected when the power supply system is operated. Do not operate the system with the output connections disconnected.

2-2-3. LOCAL SENSING. The power supply is shipped in the local sensing mode. The local sensing mode is illustrated in Figure 2. In this mode, the power supply regulates the voltage at the output terminals and does not account for voltage drop between the output terminals and load. Should optimum regulation at the load be desired, the power supply may be connected in the remote sensing mode. This and other useful operating modes are described in Section 2-2-4 through 2-2-8.

2-2-4. REMOTE SENSING. In the remote sensing mode, the supply voltage is regulated directly at the load terminals. As a result, regulation is not affected by the voltage drops in the leads connecting the power supply to the load. The remote sensing mode is illustrated in Figure 3. It is recommended that the sensing wires between TB1-5 and 6 to the load be a shielded twisted pair of 20 gauge AWG size.

2-2-5. REMOTE RESISTANCE PROGRAMMING WITH LOCAL SENSING. The remote resistance programming with local sensing mode allows the user to vary the ouptut voltage of the supply without proximity to the power supply. The load regulation is subject to load connection cable voltage drop. The remote resistance programming with local sensing mode is illustrated in Figure 4. It is recommended that the wires between the power supply TB1-6 and 7 to the remote resistance be a 20-gauge AWG shielded twisted pair.

2-2-6. REMOTE RESISTANCE PROGRAMMING WITH REMOTE SENSING. Remote resistance programming with remote sensing allows the user to vary the output voltage of the supply without direct proximity to the supply while maintaining consistent load regulation unaffected by load connection cable voltage drop. This mode of operation is illustrated in Figure 5. It is recommended that the wires from the power supply to the remote resistance and from the remote resistance to the load be a 20 gauge AWG shielded twisted pair.

2-2-7. REMOTE VOLTAGE PROGRAMMING WITH LOCAL SENSING. Remote Voltage Programming with Local Sensing allows the user to vary the output voltage of the supply without proximity to the supply. The aforementioned is accomplished by utilizing a programming voltage. The load regulation is subject to load connection cable drops. This mode of operation is illustrated in Figure 6. It is recommended that a 20 gauge AWG shielded twisted pair be used to connect the power supply TB1-6 and 7 to the remote programming voltage.

2-2-8. REMOTE VOLTAGE PROGRAMMING WITH REMOTE SENSING. Remote Voltage Programming with Remote Sensing allows the user to vary the output voltage of the supply without proximity to the supply while maintaining consistent load regulation. The output voltage of the power supply is varied utilizing a remote voltage source. The load regulation is not subject to load connection cable voltage drop in this mode of operation, which is illustrated in Figure 7. It is recommended that the wiring from power supply to remote voltage source and from source to load be a 20 gauge AWG shielded twisted pair.

2-2-9. AC CONNECTIONS. Install a line cord with minimum 16 gauge AWG wire with ground to the terminals marked AC, AC, and GND on TB1 at the rear of the supply, unless the supply is ordered with the line cord option. Plug this cord into a grounded, 115 VAC, 60 Hertz receptacle. Special voltage input power supplies may be provided with a plug and receptacle at the user's discretion, such as a TWIST-LOK plug for 230 VAC. The power supply is now ready to be operated.

SECTION III

THEORY OF OPERATION

3-1. GENERAL THEORY OF OPERATION.

The input AC is applied through the circuit breaker to the primary of the power transformer. AC from the load power secondary is rectified and inductive-capacitive (LC) filtered to provide the raw DC voltage for the series pass section. This voltage is also peak rectified and filtered in the boost circuit to provide a higher voltage level for the driver(s) on five to twenty-four volt units only. A separate bias winding on the power transformer provides AC voltage which is rectified and filtered to power the control circuitry.

The control circuitry contains an error amplifier and a reference voltage within a 723 Integrated Circuit Regulator. The output voltage is compared to the reference voltage and the error amplifier corrects for any difference. The correction will always oppose any change in the output voltage caused by either input line or output load variation.

The output current is sensed in the pass section and if a preset limit is reached the current limiter stage will inhibit the amplifier output and reduce the load cuurent as the load demand is increased (load resistance decreased). This sensing is of the fold back type which lowers the point of current limit as the output voltage falls.

The overvoltage protection circuitry is connected directly across the output terminals and senses the output voltage. If this voltage exceeds a pre-set level, a silicon controlled rectifier (SCR) is triggered on which shorts the output and opens the primary circuit breaker, protecting the load, the supply, and the power line.

3-2. DETAILED CIRCUIT DESCRIPTION.

The following descriptions list the components used in the F series power supplies and the function of each component used. Refer to the schematic and parts placement drawing at the rear of this manual for specific component location (Figures 13 and 12, respectively) .

3-2-1. MAIN ASSEMBLY COMPONENTS.

COMPONENT	FUNCTION
CB1	Interrupts A.C. power to the primary winding of T1 when OVP network is activated.
F1	Fuse. Protects supply from excessive current conditions.
DS1	Neon lamp- power on indicator.
T1	Power transformer. Electrostatic shielded, vacuum impregnated with epoxy varnish.
C3	Suppresses diode commutation spikes.

COMPONENT	FUNCTION
L1	Filter inductor - part of L/C filter. Reduces rectifier currents and ripple voltage to pass section.
C1-1, C1-2	Main filter capacitor - part of L/C filter. Reduces ripple voltage to pass section.
R4	Bleeder resistor. Provides discharge current path for main filter capacitors.
CR1	Rectifier. Provides additional D.C. voltage to Q20.
C2	Filter capacitor. Filters D.C. voltage from CR1.
M1	Voltmeter. Monitors output voltage. (Optional)
M2	Ammeter. Monitors output current. (Optional)
R1	The variable portion of the programming resistor network that determines the output voltage level.
R2	Variable portion of network which determines OVP trip level.

3-2-2. A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1	Determines the current needed to operate the current limit circuit (Base current to Q1).
R2	Variable portion of current limiting network consisting of R6 and R7.
R3	Variable resistor provided for ammeter calibration.
R4	Not used most models. (For ammeter calibration)
R5	Fixed portion of ammeter calibration network. See R3.
R6	Fixed portion of the current limit network. Determines the minimum value of load current that the circuit will current limit.
R7	Determines the fold back level of the current limit circuit.
R8	Current limiting resistor for protection of IC1.
R9	Absorbs Icbo of Q3A and Q3B to prevent thermal runaway.
R10	Provides stabilization in conjunction with C4.
R11	Absorbs Icbo of Q20 to prevent thermal runaway.

COMPONENT	FUNCTION
R12	Limits the current through CR3.
R13	Not used.
R14	Not used.
R15	The resistive portion of the RC network that provides frequency compensation for IC1.
R16	The fixed portion of the voltage divider in the OVP triggering network.
R17	Prevents false triggering of SCR1.
R18	Determines the minimum triggering voltage of the OVP circuit.
R19	Forms a voltage divider with R22 to provide a reference voltage at pin 4 of IC1 with respect to pin 7 of IC1.
R20	Provides a constant current (approx. 2 MA) for the programming resistors R21 and R1 (main assembly).
R21	The fixed portion of the programming resistors. Determines the minimum output voltage level.
R22	See R19.
R23	Limits the maximum current and reduces the power dissipation of Q3B.
R24	Absorbs Icbo of the pass transistors (Q1 to Q12 on rear deck assembly).
R25	In conjunction with C8 provides stabilization of the current limit network.
R27	Limits the maximum current and reduces the power dissipation of Q3A.
R28	Emitter resistor of Q3A. Provides current sharing between Q3A and Q3B.
R29	Emitter resistor of Q3B. Provides current sharing between Q3A and Q3B.
R30	In conjunction with C7, improves transient response and reduces output ripple.
R31	Absorbs 1 cbo of pass transistors (Q1 through Q12 on rear deck assembly)
C1	Filter capacitor for bias supply.
C2	Provides current limit delay at turn on.

COMPONENT	FUNCTION
C3	The capacitive portion of the RC network that provides frequency compensation for IC1.
C4	Provides stabilization in conjunction with R10.
C5	Delays the response of the OVP circuit to prevent false triggering.
C6	Reduces noise from reference portion of IC1. Prevents overshoot at turn-on.
C7	In conjunction with R30, improves transient response and reduces output ripple.
C8	In conjunction with R25, provides stabilization of the current limit network.
CR1	Bridge rectifier, provides D.C. voltage for the bias supply.
CR2	Provides temperature compensation for the current limiting transistor (Q1).
CR3	12 volt zener diode. Provides regulated voltage for IC1.
CR4	Zener diode. Provides reference voltage for OVP network.
CR5	Provides protection for IC1.
CR7 & CR8	Rectifier diodes. Protect IC1 inputs.
Q1	Current limit transistor - during current limit Q1 conducts, thus decreasing the available output voltage of IC1 (Pin 10).
Q2	Provides drive to Q3A and B.
Q3A	Current amplifier. Supplies base drive to Q20 (Rear Deck Assembly).
Q3B	Current amplifier in parallel with Q3A (see Q3A).
Q4	OVP transistor. Provides a gate signal to SCR1 during OVP conditions.
IC1	Voltage regulator integrated circuit. Provides reference and control circuitry for regulator loop.

3-2-3. A3 REAR DECK ASSEMBLY COMPONENTS.

COMPONENT	FUNCTION
Q1 - Q12	Pass transistors - connected in parallel for current sharing.
Q20	Driver transistor - provides current amplification for pass stage
R3	Not used all models.
CR1 - CR4	Powers rectifiers. Configured either full wave bridge or full wave center tap depending on current requirements.
TH1	Protects the power supply from failing during an over heated condition by removing the drive from IC1 signal (Optional).

3-2-4. A3A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1-1 to R1-12	Emitter resistors. Provide current sharing for Q1-Q12. Also used for current limit sense resistors.
R2-1 to R2-3	Current limit sense averaging resistors.
R3	Output bleeder resistor. Provides discharge current path for C1.
R4	Current limit resistor. Limits surge through CB1 and SCR1 when power supply goes into OVP mode.
CR1	Isolates unfiltered voltage from the output. Conducts current through SCR1 to short circuit the output during OVP operation.
SCR1	Short circuits output during OVP mode (Optional).
C1	Output capacitor. Reduces output noise and provides closed loop stabilization.

3-2-5. uA 723 I.C. PIN DESIGNATION.

PIN NUMBER	FUNCTION
1.	No connection.
2.	Internal current limit - not used.
3.	Internal current limit - not used.
4.	Inverting input.
5.	Non-inverting input.

PIN NUMBER	FUNCTION
6.	Reference voltage - nominal 7.1 VDC.
7.	Common.
8.	No connection.
9.	Not used.
10.	Output.
11.	Input voltage to output stage of IC.
12.	Input voltage to low level stages of IC.
13.	Frequency compensation and external current limit control of IC.
14.	No connection.

SECTION IV

OPERATING INSTRUCTIONS

4-1. GENERAL OPERATING INSTRUCTIONS.

The RS, RX, or RJ F series power supply has a minimum of controls and is not difficult to operate. All controls used in normal operation are placed on the front panel and input/output connections are at the rear. The supply may be turned on and off with the circuit breaker on the front panel. Output current and voltage may be monitored by optional front panel ammeter and voltmeter. On models not equipped with a voltmeter, output voltage may be monitored with the test jacks provided. All control adjustment procedures are detailed in Section V, Maintenance Instructions.

4-2. CONTROL FUNCTIONS.

The front panel of the F series power supply contains a circuit breaker, fuseholder, pilot lamp, and voltage adjust control. Also on units equipped with OVP there is an OVP set point adjust control. Metered units contain a front panel ammeter and voltmeter, voltage test jacks are provided on nonmetered units. The function of each of these components follows.

1. CIRCUIT BREAKER. Protects power supply and power line from catastrophic failure in unusual conditions. Also used as an on/off switch for the power supply. Protects the power supply (and gives visual indication) during over voltage protection.

2. PILOT LAMP. Indicates that power supply is on. Pilot lamp will glow red when input AC is energized and circuit breaker is in the "on" position.

3. FUSEHOLDER. Contains primary circuit fuse which protects power transformer (and supply) from catastrophic failure.

4. OVP ADJUST POTENTIOMETER. Lockable screwdriver adjustment provided on units with OVP option to set over voltage protection set point.

5. VOLTAGE ADJUST POTENTIOMETER. Lockable screwdriver adjustment provided to set output voltage within its normal range. See Table 1 for voltage adjust ranges available on standard units.

6. AMMETER. Optionally provided meter to monitor the current being delivered to the load by the power supply.

7. VOLTMETER. Optionally provided meter to monitor the voltage at the power supply output terminals. On units without the meter option, red (positive) and black (negative) test jacks are provided for this purpose.

4-3. NORMAL OPERATION.

Consult Section 2 for preparation for use and installation instructions. After the power supply is installed, place the circuit breaker in the upward or "on" position to operate the unit. The pilot lamp will come on and the voltmeter (if equipped) will register the nominal output voltage of the power supply. No initial adjustments are required.

4-4. OVER VOLTAGE PROTECTION.

If a supply voltmeter registers between 1.0 and 1.5 volts D.C., the supply may be in the OVP mode. The output protection crowbar circuit has tripped due to an overvoltage condition at the output terminals caused either internally or externally to the power supply. The power supply may be reset to normal operation by turning the circuit breaker to the off position and turning back on (up position) after one or two seconds. Failure of the supply to attain rated output voltage after trying this procedure is a fault condition and the operator should refer to paragraph 5-2, Troubleshooting Instructions.

4-5. SHUTDOWN.

No special procedure is required for power supply shutdown. Flipping the circuit breaker down to the "OFF" position turns off the supply.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. ROUTINE MAINTENANCE.

The only routine maintenance of the RS, RX, or RJ F series power supply necessary is cleaning and annual calibration of the meters. For calibration, refer to Performance Verification. For other than routine maintenance, refer to paragraph 5-2, Troubleshooting Instructions and paragraph 5-17, Disassembly, Repair, Replacement, Reassembly. The F series power supplies are designed for years of trouble-free service. The only physical maintenance required is once or twice per year (depending on how dirty the environment in which they are mounted) the power supply should be cleaned of dust which may accumulate. Since the power supply is convection cooled, a great accumulation of dust on the perforated dust cover and rear heat sink fins may in time hinder the free flow of cooling air. This dust accumulation may be removed with a brush or vacuum cleaner with a brush attachment.

5-2. TROUBLESHOOTING INSTRUCTIONS.

Table 3 lists possible equipment malfunctions which may occur to the F series power supply during normal operation. The Table gives symptom, possible cause, and remedy to restore equipment to normal operation. When trouble occurs, systematically check all fuses, primary power lines, and external circuit elements and wiring for malfunction before trouble shooting the power supply equipment. Malfunctions can often be traced to simple causes such as improper sensing, connections, or fuse failure due to fatigue.

5-3. VOLTAGE ADJUST SETTING PROCEDURE.

The voltage adjust pot is a locking type screwdriver adjust potentiometer, located on the front panel. To adjust, loosen the locking nut with a 1/2" wrench and turn the potentiometer with a standard flat screwdriver clockwise to increase voltage and counter-clockwise to decrease voltage. Observe output voltage reading on the voltmeter, set potentiometer to obtain desired output voltage, and re-lock by tightening 1/2" locking nut in a clockwise direction.

5-4. CURRENT LIMIT SETTING ADJUSTMENT.

The correct setting of the current limit adjust potentiometer (see schematic and parts placement drawings for location of this control) is such that the supply will begin to foldback its output voltage when output current reaches 110% of rated 40°C current. See Table 1 for correct rated current value.

TABLE 3.

TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
No output voltage	No A.C. Input.	Line cord frayed or pinched-replace.
		AC receptacle inoperative - check line fuses or breaker.
	Blown fuse, F1.	Check fuse F1 on front panel.
	Faulty wiring.	Check output connections for tightness on TB1, E1 and E2.
		Check output cables to equipment being powered for shorts or open leads.
	Faulty rectifiers.	Check main rectifiers CR1 thru CR 4 for presence of voltage. Rectifiers may be shorted if no voltage present. Likewise, check for voltage at emmiter of pass transistors Q1 thru Q12. Replace open or shorted components.
	Faulty regulator I.C.1	Replace regulator I.C.1 if above steps do not return output voltage to normal.
Output voltage low	Power supply operating in current foldback mode.	Remove load, check load value and check for shorts and/or improper supply-load connections.
	Power supply in over voltage protection mode.	Turn A.C. circuit breaker off, turn on after one or two seconds.
		If output does not come up, check OVP adjust setting. (see paragraph 5-6).
		If OVP is set at max and output does not come up, check OVP circuit components: A1-CR4, A1-Q4, A3A1-SCR1, A3A1-CR1.
	Faulty current limit transistor A1Q1.	Check current limit transistor for short, replace.
	Voltage regulator I.C.1 loose.	Check I.C.1 for tightness in socket.

TABLE 3. TROUBLESHOOTING (Sheet 2 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
Cannot adjust output voltage	Damaged voltage adjust control pot R1.	Check voltage adjust pot R1 on front panel for short or open, replace as required.
	Module operating as constant current source at current limit value.	Remove load, check load value and check for shorts and/or improper supply-load connections.
Output voltage too high	Improper output terminal connections.	Check output connections E1, E2 to equipment being powered.
	Shorted pass transistor(s) Q1 thru Q12.	Check pass transistor(s) Q1 thru Q12 for short, replace if necessary.
Poor voltage regulation	Loose load connections.	Check supply-load connections.
	Improper sensing connections.	Check supply-load voltage sensing connections. See Section 2-2.
	Voltage regulator I.C.1 loose.	Check that voltage regulator I.C.1 is tight in socket.
	Faulty voltage regulator I.C.1.	Replace I.C.1 if above steps do not help.
High ripple on output	Improper ground connections	Ground positive or negative output terminal at the module.
	Faulty filter capacitor(s) C1-1 and C1-2.	Replace main filter capacitor(s) if ripple is more than 2 volts.
	Faulty rectifier(s) CR1 thru CR4.	Check rectifier diodes for short if ripple is over 2 volts, replace if shorted.
Power supply overheats	Output current too high.	Check that output current does not exceed rated value (see Table 1). If over, check load requirement.
	Poor ventilation.	Check power supply dust cover and cooling holes (and fins where applicable) for blockage by dust or improper installation. (See Section 1-6.)

5-5. CURRENT LIMIT ADJUSTMENT PROCEDURE.

The adjustment procedure requires that the power supply module is disconnected from associated equipment, is at an ambient temperature of 25-30°C, and has not been operated with load for at least one hour. Whenever rated output current of the supply module cannot be attained, adjust the current limit potentiometer as follows:

1. Determine current limit potentiometer designation by referring to schematic in Figure 13. Locate this potentiometer on the module A1 circuit card by referring to Parts Placement Diagram, Figure 12.

2. Remove A.C. power from power supply system and gain access to current limit potentiometer by removing A1 circuit card.

3. Connect power supply for constant voltage with local sensing as shown in Figure 9.

4. Turn voltage adjust control on front panel to minimum output voltage obtainable.

5. Apply a resistor load to output terminals so that output current is 110% of 40°C rating of unit. Refer to Table 1, Table of Specifications for correct rated output current.

6. Using an oscilloscope, Tektronix 503 or equivalent, observe output voltage of supply while adjusting current limit potentiometer in a CCW direction. Adjust until output ripple increases sharply and oscilloscope pattern changes.

7. Recheck setting by increasing load from rated value to 110% of rated value and observing oscilloscope for sharp increase in output ripple at 110% point. Repeat procedure if necessary.

8. Reassemble A1 circuit card into power supply and fasten on top cover.

5-6. OVER VOLTAGE PROTECTION ADJUSTMENT.

The correct setting of the over voltage protection potentiometer (located on the front panel of the supply) is at 120% of rated output voltage of the supply. Refer to Table 1 for correct output voltage of the unit.

5-7. O.V.P. ADJUSTMENT PROCEDURE.

The adjustment procedure requires that the power supply be disconnected from associated equipment.

1. The OVP potentiometer is on the front panel of the G series power supply.

2. Turn the OVP adjust potentiometer fully clockwise. The correct OVP setting is 120% of the rated output voltage of the module being adjusted. Refer to Table 1.

3. Turn on the power supply and raise the output voltage to this desired over voltage protection point. Monitor output voltage on the front panel voltmeter (or connect an external voltmeter to the test jacks provided) and raise voltage by adjusting front panel volt adjust potentiometer.

4. Slowly turn the OVP potentiometer counter-clockwise until the voltmeter suddenly drops to between 1 and 1.5 volts, indicating that the over voltage protection point is reached.

5. The over voltage protection point is now set. Turn off power supply and turn down voltage adjust potentiometer before turning on power supply again.

6. Turn on supply and reset output voltage to correct nominal value. Refer to Section 5-3 for specific voltage adjust setting procedure.

5-8. PERFORMANCE VERIFICATION.

It may be necessary to check the performance of the F series power supply periodically. Specific parameters of performance are given for each of the power supply models in the F series in Table 2, Table of Specifications. The power supply parameters may be verified with the test set-up illustrated in Figure 9. This testing is to be performed by a trained electronic technician utilizing the following equipment (or equivalent).

1. A variable resistor load capable of dissipating 500 watts at .058 ohms setting for the RJF 5, less wattage is necessary for higher voltage supplies.

2. A D.C. ammeter, 0 to 150 amps, ± 2% accuracy.

3. An A.C. ammeter, 0 to 20 amps, ± 2% accuracy.

4. An RMS voltmeter, Ballantine model 320 or equivalent.

5. A digital voltmeter (DVM), Data precision 902 or equivalent.

6. An A.C. variac, switched, with grounded 3-wire receptacle, capable of supplying 20 amps A.C.

7. An A.C. voltmeter, 0-150 VAC, ± 5% accuracy.

8. An oscilloscope, Tektronix model 503 or equivalent.

9. A 5-position terminal board to make connections to the power supply under test.

5-9. LINE REGULATION.

Turn on power supply and load to full rated current at 40°C, as listed in Table 1. Measure and record the output voltage of the supply using the DVM at 105 volts A.C. input. Turn up the variac to 132 volts A.C. input to the supply and measure and record output voltage. The difference between these output readings should not exceed 0.01% of the maximum reading noted for RSF supplies, or 0.1% of the maximum reading for RXF and RJF supplies.

5-10. RIPPLE.

Measure the RMS ripple on the output of the supply using the RMS voltmeter with the supply at full load as determined in paragraph 5-9 and at nominal A.C. input voltage. Ripple on the D.C. output should not exceed 1.0 millivolts RMS.

5-11. NOISE.

Measure noise on the output of the power supply using the oscilloscope with the supply at full load as in paragraph 5-10. Noise should not exceed 3.0 millivolts peak-to-peak.

5-12. LOAD REGULATION.

With the supply at nominal input A.C. voltage, load to full rated current as determined by Table 1, and measure and record the output voltage on the DVM. Remove the load and measure and record output voltage. The difference between these readings should not exceed 0.01% of the maximum reading obtained for RSF supplies, or 0.1% of the maximum reading for RXF and RJF supplies.

5-13. METER CALIBRATION.

The front panel voltmeter and ammeter (if equipped) may be checked for accuracy when testing the performance of the supply. Load the supply to full load as in paragraph 5-9 and compare the reading of its ammeter to the external test ammeter connected as in Figure 9. Ammeter calibration may be reset by adjusting R3 on the A1 circuit card. Also compare the supply voltmeter with the DVM. A reading greater than 5% between the supply voltmeter and DVM is not acceptable and replacement of the supply meter is advised.

5-14. OVERVOLTAGE PROTECTION CHECK.

The overvoltage protection circuit may be checked on the supply while in the test set-up of Figure 9. Refer to paragraphs 5-6 and 5-7 for OVP check and reset procedure.

5-15. CURRENT LIMITER CHECK.

The power supply current limiter circuit may be checked using the test set up of Figure 9. With supply on and nominal A. C. input voltage applied, load the supply to full load as in paragraph 5-9. Increase load current (decrease load resistance) slowly until the output voltage begins to drop. This is the current limit point. The current limit point or point where output voltage begins to drop should be approximately 110% of the rated output current at 40°C.

5-16. DEVIATIONS.

Any deviations from standard as noted in paragraphs 5-9 through 5-15 when performing any or all tests described may constitute a power supply failure. Refer to paragraph 5-2, Troubleshooting Instructions for possible causes and remedy of power supply failure.

5-17. DISASSEMBLY, REPAIR, REPLACEMENT, REASSEMBLY.

Repair of the G series power supply will be limited to replacing defective components found in performance of Maintenance and Troubleshooting techniques as described in paragraphs 5-1 and 5-2, respectively. For location of specific parts and assemblies, please refer to the Parts Placement Diagrams, Figure 12.

5-17-1. DISASSEMBLY. Disassemble parts in a logical fashion and save all hardware including locking washers so that it may be reassembled as it was taken apart. There are four (4) screws holding the power supply top cover. There are two (2) screws holding the A1 circuit card in place near the front of the unit.

5-17-2. REPAIR, REPLACEMENT. Repair of the power supply and its components is limited to replacement of defective components with new ones and testing as described in paragraph 5-8, Performance Verification. When working with the printed circuit board(s) contained within the power supply, the following techniques should be adhered to if it becomes necessary to change components.

1. Always use a heat sink when soldering transistors and diodes.

2. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

3. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process. Place the wick onto the soldered connection and apply soldering iron onto the wick. When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

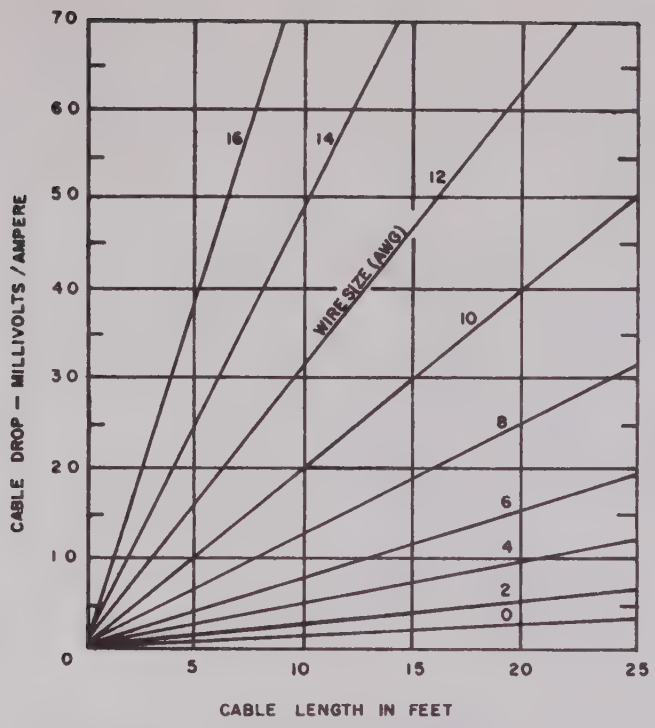
5-17-3. REASSEMBLY. Reassemble the power supply in reverse procedure to that used in disassembly. Be sure to fasten all screws with locking hardware and tighten snugly. Rewire all terminal boards as necessary observing correct placement of each wire. Refer to **Figure 12** for complete parts placement diagrams. Upon completion of reassembly refer to paragraph 5-8, Performance Verification, for checking out operation of the power supply.

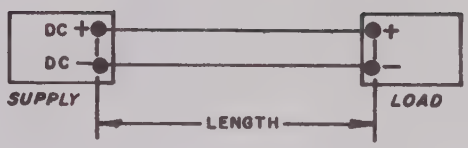
5-18. PACKING FOR RESHIPMENT.

When packaging a power supply for reshipment, roll up the power cord (if equipped) and tie it securely to the rear of the supply. Provide protection around the meter faces and handles on the front panel by building up layers of cardboard next to these items. To prevent scratching and keep out dampness the system may be tied in a plastic bag prior to sealing in a cardboard box. A dessicant may be added to the plastic bag to absorb moisture. The shipping container may be a corrugated, cardboard box tailored to fit the supply snugly or fitted with wadding or rolled-up newspaper. The power supply should not be loose in its shipping container. Mark container adequately as to contents.

5.19. STORAGE INSTRUCTIONS.

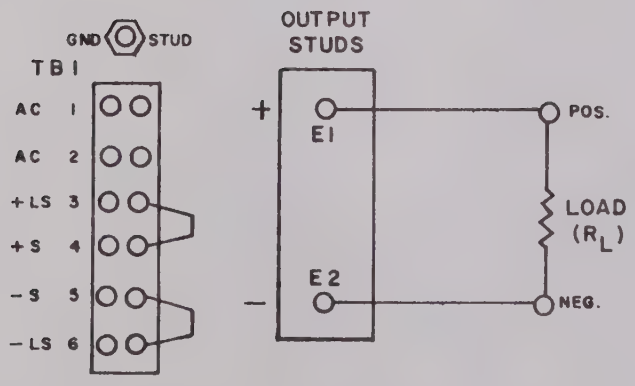
The power supply may be stored open or boxed as in paragraph 5-18. Storage temperature range permissable is -55°C to +85°C. If a power supply is to be stored for a long period of time, a waterproof or overseas shipping container should be used. Avoid storage of electronic equipment in damp areas. When reactivating stored systems after eighteen months or more, it is advisable to check performance as in paragraph 5-8, Performance Verification.





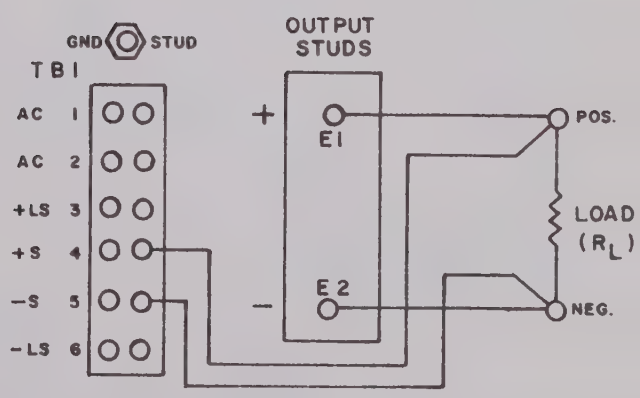
Cable Drop, Millivolts/Ampere, as a Function of Cable Length.

FIGURE 1.



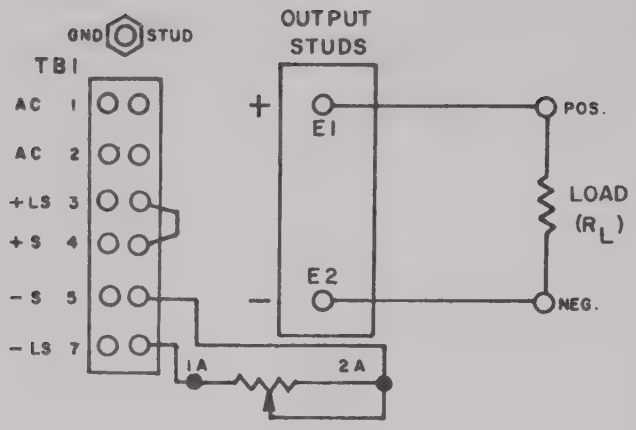
Local Sensing.

FIGURE 2.



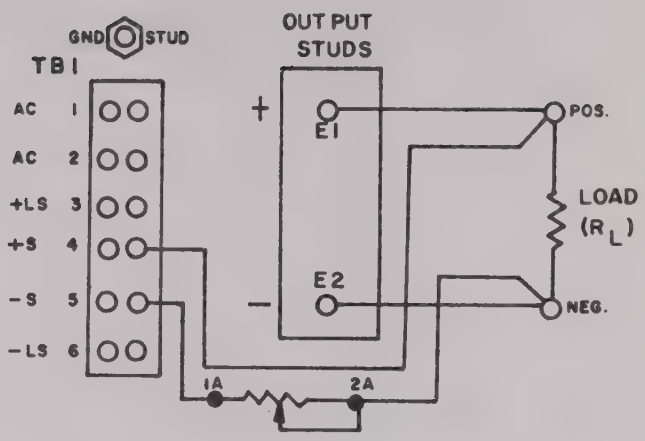
Remote Sensing.

FIGURE 3.



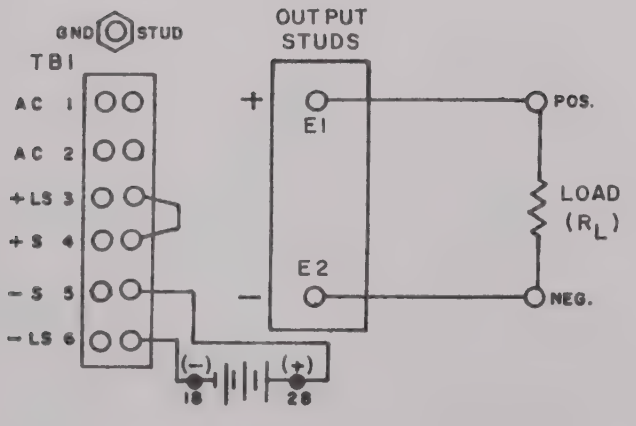
Remote Resistance Programming with Local Sensing.

FIGURE 4.



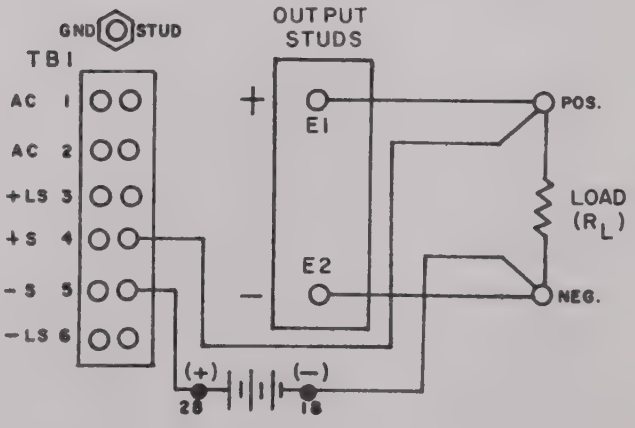
Remote Resistance Programming with Remote Sensing.

FIGURE 5.



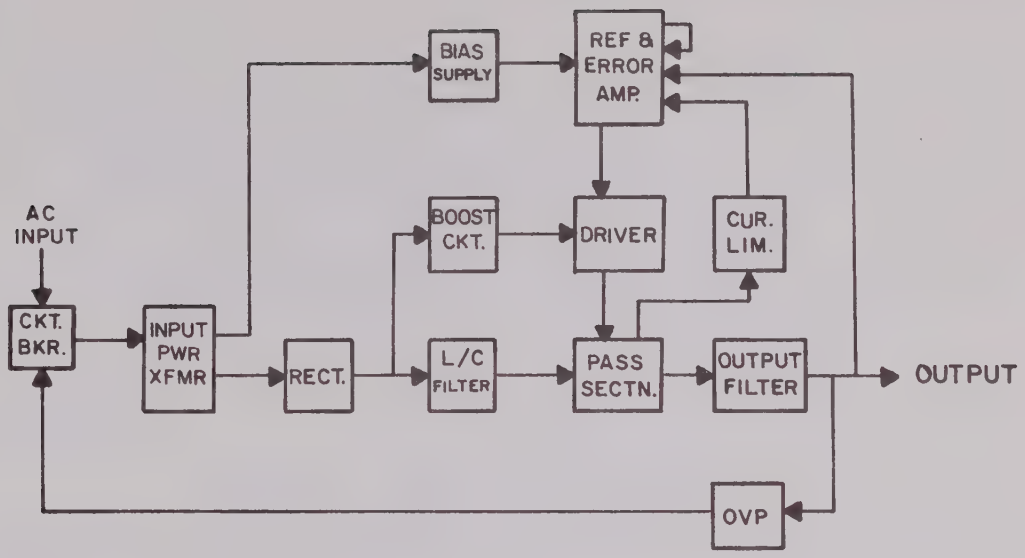
Remote Voltage Programming with Local Sensing.

FIGURE 6.



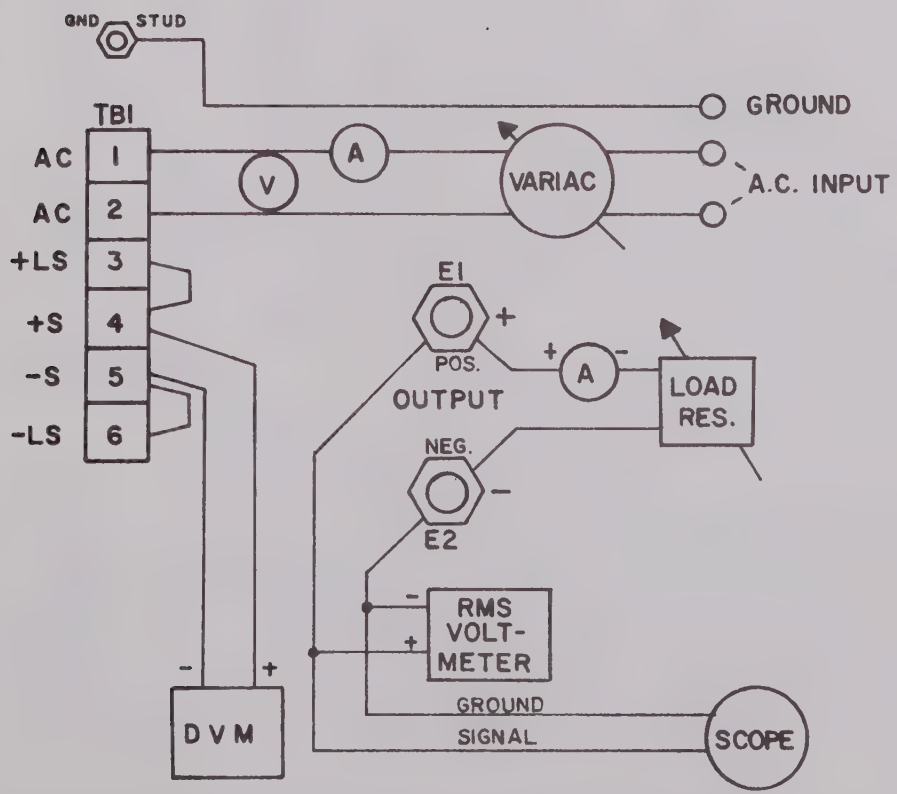
Remote Voltage Programming with Remote Sensing.

FIGURE 7.



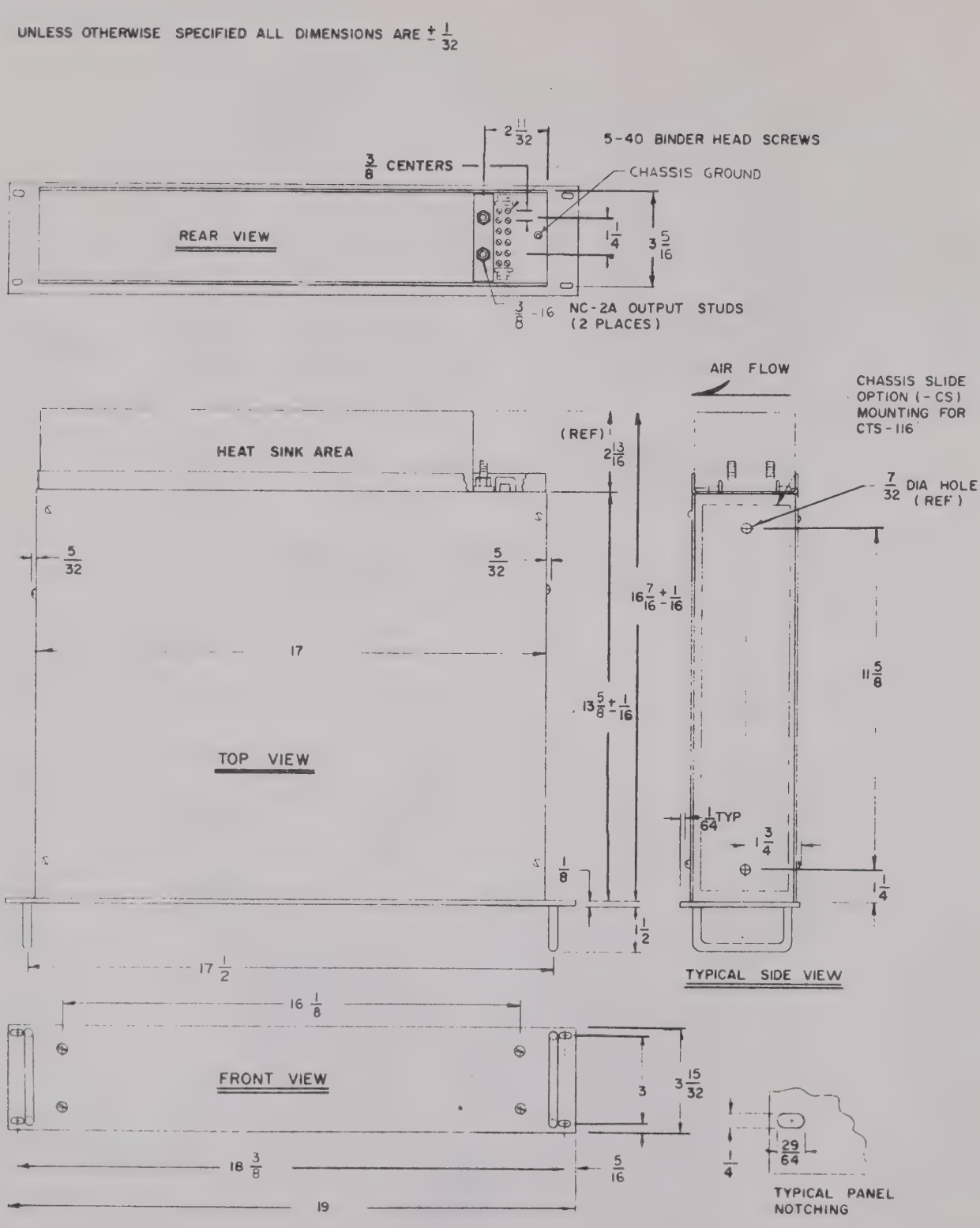
General Circuit Block Diagram.

FIGURE 8.



Test Connections for Performance Verification.

FIGURE 9.

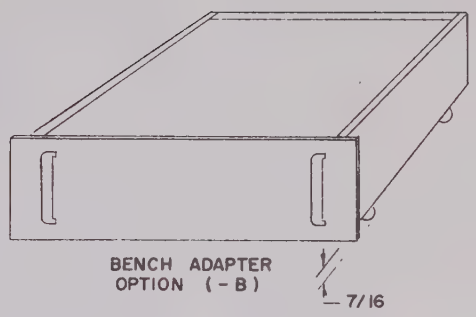


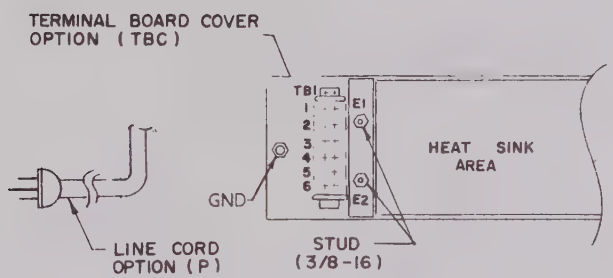
Outline Drawing.

FIGURE 10.

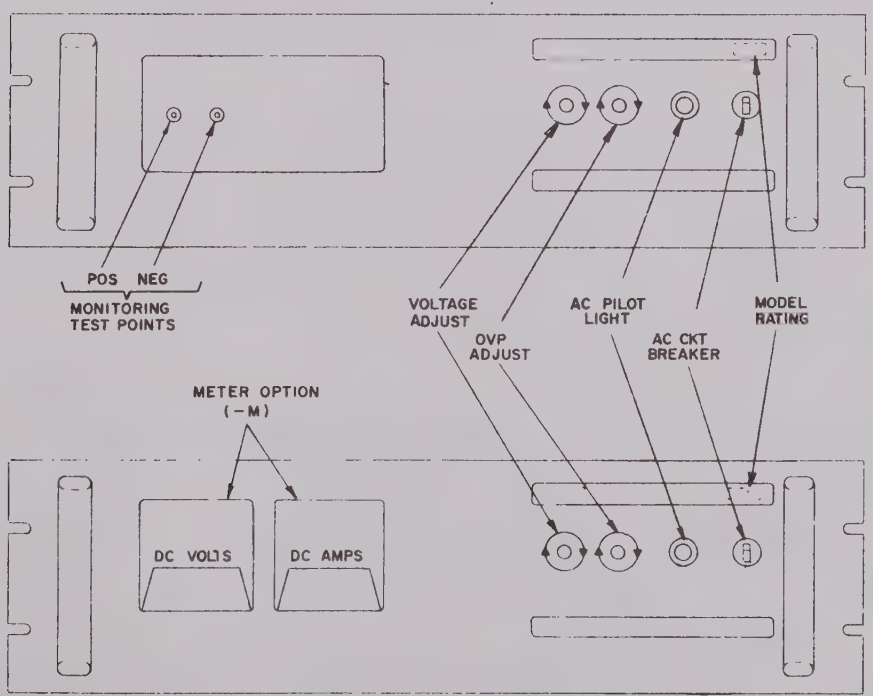
d

RSF	TB1 TERMINAL BOARD LEGEND		
TERM NO	FUNCTION	RECOM'D WIRE SIZE	REMARKS
1	AC	NO 16 AWG	HIGH SIDE OF AC INPUT
2	AC	NO 16 AWG	RETURN SIDE OF AC INPUT
GRD STUD	G	NO 16 AWG	AC GROUND
3	+LS		INTERNALLY WIRED TO + OUT
4	+S	NO 20 AWG	NORMALLY JUMPED TO +LS
5	-S	NO 20 AWG	NORMALLY JUMPED TO -LS
6	-LS		INTERNALLY WIRED TO -OUT
E1	POS OUT	AS REQD	STUD(1/4-20RSF)(3/8-16RSG AND RSH)
E2	NEG OUT	AS REQD	STUD(1/4-20RSF)(3/8-16RSG AND RSH)





REAR VIEW ELEMENTS



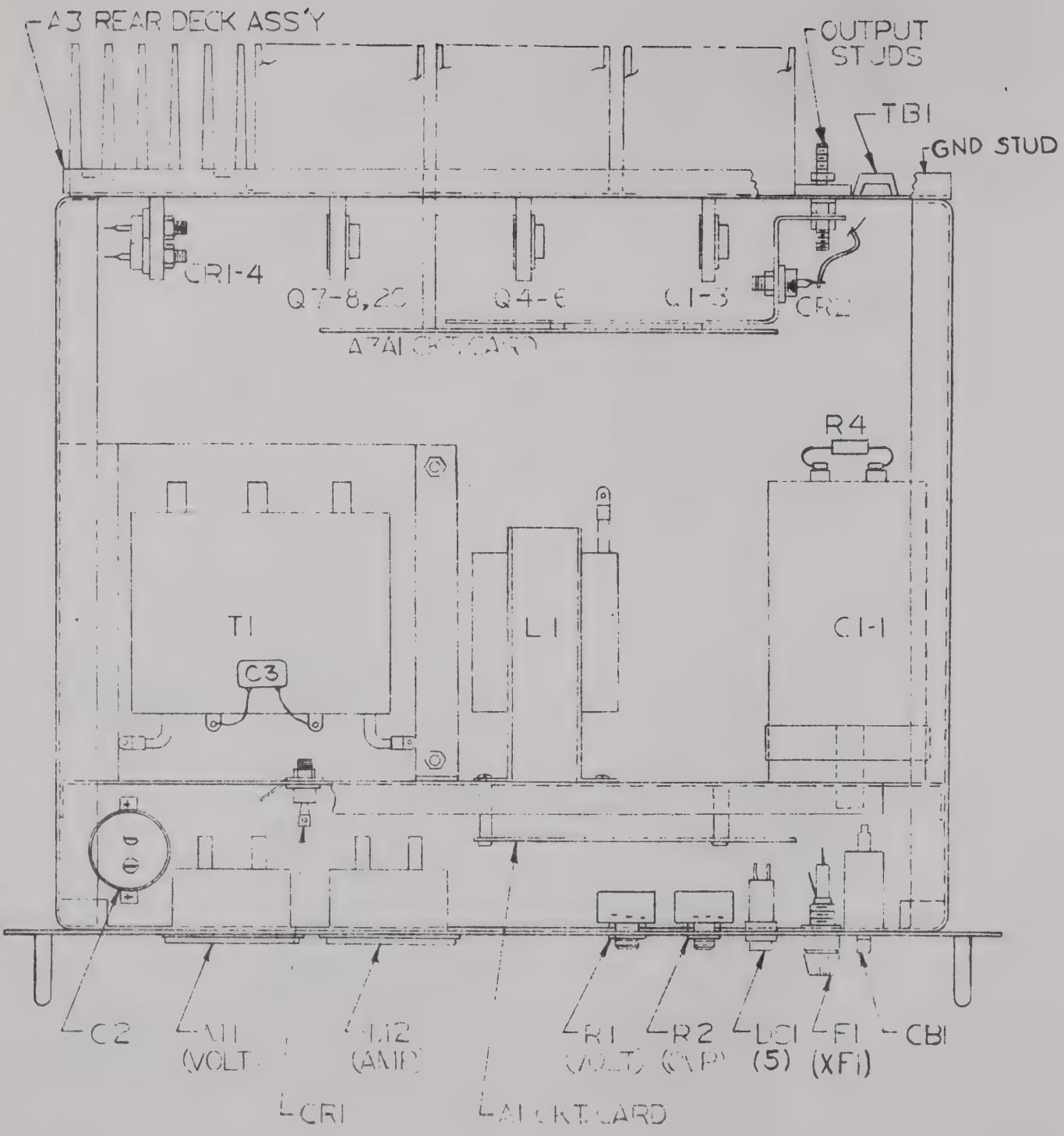
NON - METERED
PANEL ELEMENTS
(FRONT VIEW)

METERED
PANEL ELEMENTS
(FRONT VIEW)

Interface Drawing.

FIGURE 11.

e



Parts Placement Diagram
"F" Series, Top View, Cover Removed.

FIGURE 12.

f

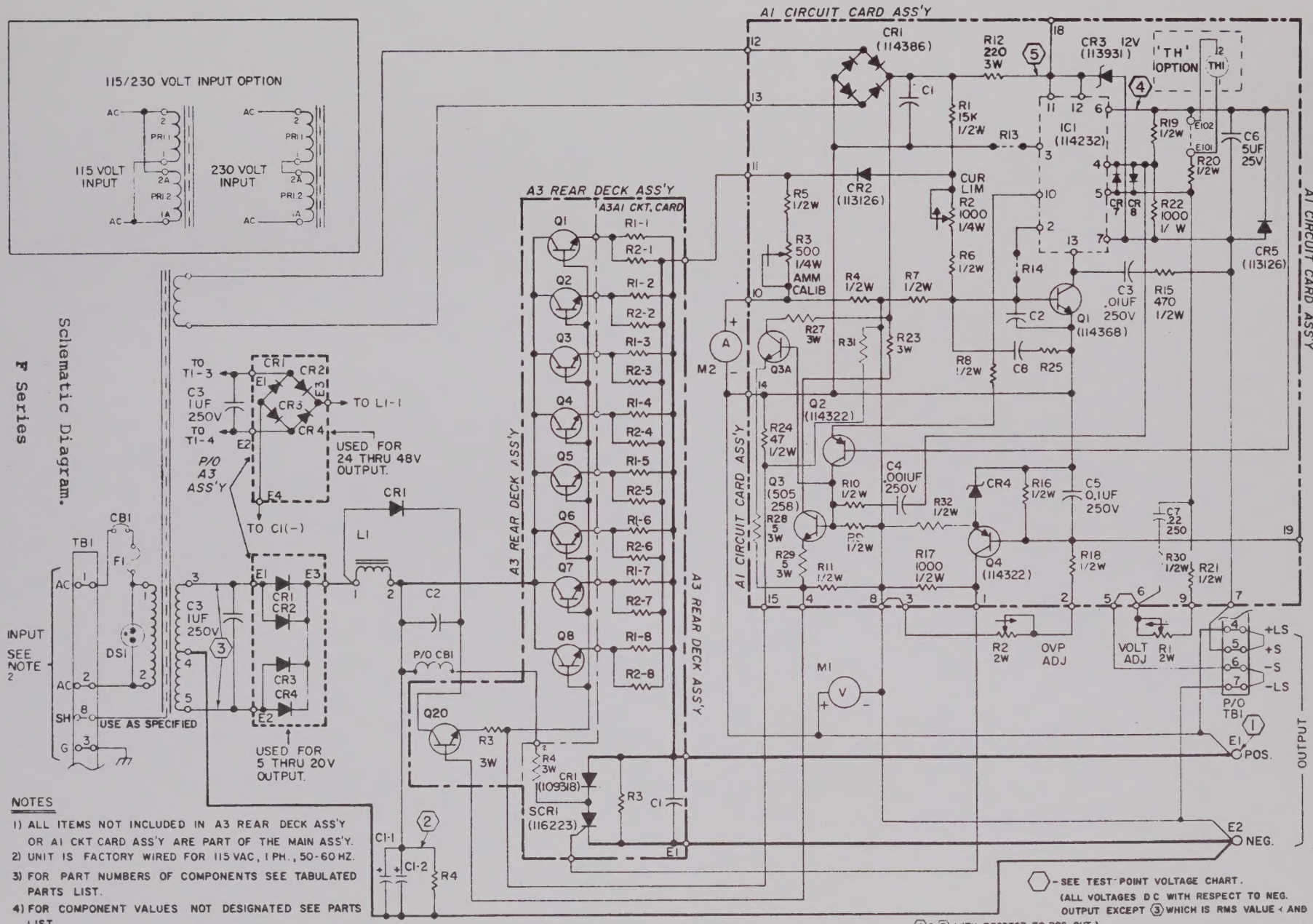
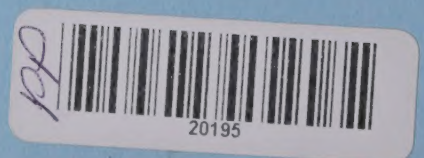


FIGURE 13. Schematic Diagram. F Series

NOTES

1) ALL ITEMS NOT INCLUDED IN A3 REAR DECK ASS'Y OR A1 CKT CARD ASS'Y ARE PART OF THE MAIN ASS'Y.
2) UNIT IS FACTORY WIRED FOR 115 VAC, 1 PH., 50-60 HZ.
3) FOR PART NUMBERS OF COMPONENTS SEE TABULATED PARTS LIST.
4) FOR COMPONENT VALUES NOT DESIGNATED SEE PARTS LIST.
5) SCHEMATIC ILLUSTRATES THE FOLLOWING OPTIONAL FEATURES/EQUIPMENT: OVERVOLTAGE PROTECTION, METERS, 115/230 VAC INPUT, AND THERMOSTAT.
6) NOT ALL PARTS SHOWN ARE REQUIRED - INDIVIDUAL PARTS LISTS GOVERN.

⬡ - SEE TEST POINT VOLTAGE CHART. (ALL VOLTAGES DC WITH RESPECT TO NEG. OUTPUT EXCEPT ③ WHICH IS RMS VALUE < AND ④ & ⑤ WITH RESPECT TO POS. OUT.)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